CURRENT RESEARCH AND DEVELOPMENT IN BIOTECHNOLOGY ENGINEERING AT IIUM

VOLUME II

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Department of Biotechnology Engineering
Faculty of Engineering
International Islamic University Malaysia

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RECYCLING OF WASTE RUBBER VIA MICROBIAL DEVULCANIZATION

Faridah Yusof and Ainie Asyikin Ahmad

Department of Biotechnology Engineering, Faculty of Engineering,
International Islamic University Malaysia, P.O. Box 10, 50728 Kuala Lumpur, Malaysia

ABSTRACT

Microbial devulcanization uses bacterial enzyme secretion to break the sulfur bonds in the vulcanized rubber structure. This study aims at optimizing the process conditions for devulcanization of rubber particles, in shake flasks, using tetrathionate hydrolase releasing *Thiobacillus ferrooxidans*. When factorial experimental designs were applied, results showed that the optimum conditions for rubber degradation to achieve the highest tensile strength upon revulcanization was by cultivating the bacteria at an optimized conditions namely, an initial pH of 4, at 25°C, with the following salt concentrations in (g/100ml) of KH_2PO_4 = 0.4g, $(NH_4)_2SO_4$ = 0.4g, and $MgSO_4.7H_2O$ = 0.01g and shaking it at an agitation speed of 250 rpm for a period of 24 hours with 7g/100ml pulp density. The FESEM analyses show a differential surface change in the rubber incubated in the optimized conditions where cavities were uniformly visible throughout the surface. On revulcanization of treated rubber, the highest strength reading obtained was 8.21 MPa, an increase of 32.42% from the untreated rubber. This work is important because it is an environmental-friendly and safe method of devulcanization and with thorough study it is hoped that the objective to recycle higher percentage of waste rubber can be achieved.

Keywords: *Thiobacillus ferroxidans*, tetrathionate hydrolase, microbial devulcanization, optimization, recycling rubber product,

INTRODUCTION

Near to a billion discarded scrap tires are being produced worldwide and the quantity is increasing every year. To find the method to dispose scrap tires are the major environment problem throughout the world today. The only environmentally sound way to dispose scrap tires in large quantity is to burn it in the cement kiln (E-waste management, 2008). Scrap tires virtually indestructible if left in the dump site as it cannot biodegrade even in 50 years. To date, recycled rubber has not been used as a replacement for new or synthetic rubber in significant quantities, largely because the desired properties have not been achieved. It is estimated that less than 10% of waste rubber is reused in any kind of new product. Various devulcanization processes have failed to result in significant devulcanization, have failed to achieve consistent quality, or have been prohibitively expensive.